

EPA Evaluation of Exposure Parameter Value Discrepancies between the Portland Harbor Feasibility Study and Human Health Risk Assessment

January 2, 2020

Introduction and Purpose

In the revision of the non-cancer benzo(a)pyrene (BaP) preliminary remediation goals (PRGs) in the memo *Non-Cancer Benzo(a)Pyrene HQs and PRGs* (CDM Smith Federal Programs Corporation [CDM Smith] 2019) dated December 17, 2018 and revised October 9, 2019 (Non-Cancer BaP PRG memo), discrepancies were noted between the exposure parameter values presented in Appendix B, Table B3-1 of the Portland Harbor feasibility study (FS) and Tables 3-21, 3-22, and 3-24 of the Portland Harbor human health risk assessment (HHRA). Although in the Non-Cancer BaP PRG memo, the EPA evaluated whether these discrepancies in the exposure parameters would impact the cancer BaP PRG calculations that were presented in the proposed explanation of significant differences (ESD)¹ and FS, there was also concern whether the discrepancies in the human health exposure parameters impact the cancer and non-cancer calculations for contaminants of concern (COCs) other than BaP in the FS.

To address this concern, calculations from the following FS tables (EPA 2016b) were examined in this memorandum:

- FS Table B3-4 Risk-Based Human Health PRGs for RAO 1
- FS Table B3-5 Risk-Based Human Health PRGs for RAO 2 (fish tissue calculations only)

Discrepancies in the exposure parameters resulted in calculation errors for cancer risk and non-cancer hazard for RAO 1 in FS Table B3-4, but the errors in FS Table B3-4 did not change the final PRG selection. The calculation errors in FS Table B3-5 resulted in incorrect PRG values presented in FS Table 2.2-5 and incorrect ROD Table 17 fish tissue target levels. This memorandum details the calculation evaluation and findings.

In addition, this memorandum includes errata pages for FS tables that were identified to have errors in the memorandum for Errata #2 for Portland Harbor Superfund Site Record of Decision ROD Table 17, dated December 12, 2019.

Recalculation of FS Table B3-4

To recalculate the cancer and non-cancer PRGs in FS Table B3-4, exposure parameters presented in HHRA Tables 3-21, 3-22, and 3-24 and formulas in the HHRA were used along with the toxicity values and chemical-specific parameters presented in FS Table B3-2 (EPA 2016a, 2016b). A summary of the exposure parameters used in the recalculation of PRGs is provided in **Table 1**; and the chemical-specific toxicity values are provided in **Table 2**. The results of the recalculations are provided in **Table 3**.

When the cancer and non-cancer PRGs in **Table 3** are compared to those in FS Table B3-4, the results are comparable – with the exception of calculations for the Transient (beach sediment exposure scenario), the Diver Dry Suit (in-water sediment exposure scenario), carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and a few 10⁻⁴ target cancer risk results for polychlorinated biphenyls (PCBs). These exceptions are discussed further below:

- Transient, beach sediment exposure scenario: As identified in the Non-Cancer BaP PRG memo, a review of the FS Excel calculation file for this receptor uncovered several formula errors for the non-cancer averaging time, the exposure frequency (50 days instead of 365 days), the exposure duration (25 years instead of 2 years), the exposed skin surface area (3,300 square centimeters [cm²] instead of 5,700 cm²), and the adherence factor (0.2 milligrams per square centimeter [mg/cm²] instead of 0.3 mg/cm²). The calculated PRG values in **Table 3** in the transient receptor column for all the COCs in FS Table B3-4 were already recalculated and presented in the

¹ The ESD was finalized on December 9, 2019.

Non-Cancer BaP PRG memo. Because the transient exposure scenario was determined to not be the risk driver exposure scenario, these errors do not impact the selected PRG values in the FS.

- Diver – Dry Suit, in-water sediment exposure scenario: Values for this scenario were not calculated in the FS, so the calculated PRG values presented in **Table 3** for this scenario are new. Diver - Dry Suit, in-water sediment exposure scenario was determined to not be the risk driver exposure scenario; thus, these new values do not impact the selected PRG values in the FS.
- Cancer and Non-cancer Calculations for cPAH: The ESD updated the cPAH calculations owing to the change in the cancer slope factor for BaP per the *Toxicological Review of Benzo(a)pyrene* (EPA 2017). The impact of this updated toxicity value on the BaP PRG values in the FS is described in detail in the ESD. Note that due to rounding, the nearshore direct contact sediment CUL calculated in the ESD is 774 micrograms per kilogram (µg/kg) (from the previous in-water sediment PRG of 106 µg/kg multiplied by a factor of 7.3) instead of the recalculated 772 µg/kg (from the unrounded PRG of 105.81 µg/kg multiplied by the factor of 7.3).
- 10⁻⁴ target cancer risk results for PCBs: Target cancer risk results for PCBs for the in-water worker, high frequency fisher, tribal fisher, and diver wet suit were rounded to the nearest hundred in the FS. The rounding of these values does not impact the selected PRG values in the FS.

Although some of the revised calculated PRG values in **Table 3** differ from the calculations in FS Table B3-4, these errors do not change the PRGs that were determined in the FS (except for the changes for cPAH PRGs that are documented in the ESD).

During the recalculation, a discrepancy was noted between the COC list in FS Table B3-4 and the COC list in FS Table 2.2-4. Upon review, it was determined that the COC list in Table B3-4 is incorrect because it includes chemicals that were not identified as COCs for the indicated media. HHRA Table 7-1 - Chemicals Potentially Posing Unacceptable Risks for Human Health lists the COCs for each media. The shorter COC list on FS Table 2.2-4 matches the COCs identified for beach sediment and in-water sediment in HHRA Table 7-1.

Recalculation of FS Table B3-5

To recalculate the cancer and non-cancer PRGs in FS Table B3-5 for fish tissue, exposure parameters from the HHRA were used along with the toxicity values and chemical-specific parameters presented in FS Table B3-2 and the formulas presented in FS Appendix B Section B3.2. A summary of the exposure parameters used in the recalculation is provided in **Table 4**; and the chemical-specific toxicity values are provided in **Table 2**. The results of the recalculations are provided in **Table 5**.

When the cancer and non-cancer PRGs in **Table 5** were compared to those in FS Table B3-5, discrepancies were noted. Examination of these discrepancies uncovered the following differences:

- The tissue exposure scenario used for FS Table B3-5 was not identified in the FS by name; however, FS Appendix B Section B3.2.1 states that the risk-based PRGs were calculated for the consumption of resident fish. According to the HHRA, consumption of resident fish species consistently results in the greatest cancer risk estimates for the subsistence fisher and tribal consumers. The parameters used for the tissue exposure scenario in the FS appear to match the Subsistence Fisher and Recreational Fisher scenarios that were presented in the BHHRA with a few discrepancies.
 - The Subsistence Fisher in the FS has an exposure frequency of 350 days per year compared to the Subsistence Fisher and Recreational Fisher receptors in the HHRA which have exposure frequencies of 365 days per year. In general, an exposure frequency of 350 days per year is consistent with EPA's default value for residential exposure, which assumes daily exposure with approximately two weeks annually spent away from the site for vacation.
 - Footnote "a" on FS Table B3-5 indicates that a shellfish consumption of 3.3 g/day was used for the receptor with a fish consumption rate of 142 g/day. According to the HHRA, the Subsistence Fisher has a fish consumption rate of 142 g/day and a shellfish consumption rate of 18 g/day. The 3.3 g/day shellfish

consumption rate is consistent with the shellfish consumption rate for a central tendency Recreational Fisher in the HHRA.

- For the following comparisons to the FS Table B3-5 values for fish tissue consumption of 142 g/day, the recalculated values assumed an exposure frequency of 350 days per year:
 - The FS hazard quotient (HQ) value for mercury appears to be in the wrong units; the value is shown in $\mu\text{g}/\text{kg}$, but the units indicated by the table is milligrams per kilogram (mg/kg). The value should be 0.03 mg/kg , rounded from 0.026 mg/kg .
 - The FS 10^{-4} target cancer risk results for bis(2-ethylhexyl) phthalate (BEHP) was rounded up to the nearest hundred, and the FS 10^{-4} target cancer risk results for pentachlorophenol was rounded down to the nearest ten.
 - The HQ for the child was not calculated for hexachlorobenzene in the FS.
 - cPAH values are different due to the change in the cancer slope factor for BaP per the *Toxicological Review of Benzo(a)pyrene* (EPA 2017) and as described in detail in the ESD.
 - In the FS calculations, 2,3,4,7,8-pentachlorodibenzofuran (2,3,4,7,8-PeCDF) used a reference dose (RfD) of $2.333\text{E-}09$ instead of $2.3\text{E-}09$ as shown in Table B3-2. Due to rounding, this did not impact the recalculated PRGs for 2,3,4,7,8-PeCDF in **Table 5**.
 - The difference in the values from the Infant Consumption of Breast Milk Calculations is discussed separately below.
- In the Infant Consumption of Breast Milk Calculation for the fish tissue consumption of 142 g/day, consistent with the calculation for the Subsistence Fisher, the maternal exposure frequency of 350 days per year was used instead of a maternal exposure frequency of 365 days per year. Discrepancies between the recalculated values for the Infant Consumption of Breast Milk Calculation and the FS calculations were noted for DDx, PCBs, and PBDEs. These discrepancies are likely due to the following:
 - The body weight of the adult (70 kilograms [kg]) was used in the FS calculations instead of the maternal body weight (66 kg) as stated in Section B3.2.2.
 - The non-cancer averaging time (AT_{NC}) in the FS calculation was replaced by exposure frequency multiplied by the exposure duration ($\text{EF}_a \times \text{ED}_a$), instead of the exposure duration expressed in days (i.e., 365 days/year $\times \text{ED}_a$).
 - Table B3-2 is missing the infant RfD for DDx. However, in the FS, the Infant Consumption of Breast Milk Calculation was calculated for DDx even though it does not have an infant RfD listed in Table B3-2. The RfD value used in the FS calculation is consistent with the Infant RfD for DDT from Appendix D, Table D-1 in *Human Health Risk Assessment Guidance* (ODEQ 2010).
 - Table B3-2 lists the incorrect biological half-life of chemical in the body (h) for PCBs and PBDE. According to the referenced source (ODEQ 2010), the half-life for PCBs should be 2,550 days. The ODEQ (2010) reference does not list a biological half-life for PBDE so Table B3-2 should not have one listed for PBDE.
 - According to Appendix F, Attachment F3 of the HHRA, based on an agreement with EPA, for the calculation of noncancer hazard for PBDE through the infant breastmilk consumption pathway, an infant risk adjustment factor (IRAF) of 38 was calculated for total PBDEs and applied to noncancer hazard estimates for the adult mother. Using this methodology, the calculated fish tissue target level for PBDEs through the infant breastmilk consumption pathway is $1.28 \mu\text{g}/\text{kg}$.
- Although the Excel spreadsheet for the Recreational Fisher 49 g/day fish tissue consumption calculations was not available for comparison, it is likely that the same spreadsheet for the 142 g/day fish consumption rate was used by changing the fish tissue consumption rate. Most differences between the recalculated values and the FS

values appear to be minor, likely caused by the same discrepancies as listed above for the 142 g/day calculations (e.g., exposure parameters or rounding), except for the following:

- Values for the Recreational Fisher 49 g/day fish consumption scenario were not calculated for arsenic, mercury, and BEHP.
- cPAH values are different due to the change in the cancer slope factor for BaP per the *Toxicological Review of Benzo(a)pyrene* (EPA 2017) and as described in detail in the ESD.
- The FS 10^{-4} target cancer risk results for pentachlorophenol appears to be off by an order of magnitude.
- The recalculated infant PBDE value is 3.7 µg/kg while the FS calculated value is 4.2 µg/kg.
- During the evaluation of FS Table B3-5, the following discrepancies in the Appendix B text were noted:
 - Definition of PRG_{tissue} in Section B3.2.1 has the wrong units. Calculation of PRG using the equations (B3-15, B3-16, and B3-17) shown would result in PRG in units of mg/kg, not µg/kg.
 - Definition of ED_a in Section B3.2.2 has the wrong units. Exposure duration of the adult should be in years not days. (Note that the ED_{inf} is correctly shown in units of day.)
 - In Section B3.2.2, the formula should indicate that the Infant Consumption of Breast Milk Calculation was only conducted for chemicals with an infant RfD.
 - In Section B3.2.2, the text should describe the different methodology used for the Infant Consumption of Breast Milk Calculation used for PBDE.

The FS calculations for sediment PRGs from fish/shellfish consumption on FS Table B3-5 were not recalculated. These FS values were determined using the food web model. Due to the iterative process of the food web model, results from this model are not accurately reproduceable due to unquantifiable variables. The FS only evaluated cPAHs separately for shellfish consumption; all other COCs were evaluated using the food web model. Since cPAHs values were recalculated in the ESD due to the change in BaP toxicity, shellfish consumption calculations were not re-evaluated in this memo.

Although the PRGs in FS Table 2.2-5 list incorrect risk-based PRGs (HQ = 1) for DDx and mercury, the fish tissue target levels selected in the Record of Decision (ROD) are correct. In general, the errors uncovered in the comparison of the revised calculated PRG values in **Table 5** to FS Table B3-5 do not change the target levels that are listed on FS Table 2.2-5, with the exception of the following:

- The PRG values and fish tissue target levels for pentachlorophenol and PBDEs listed on FS Table 2.2-5 are incorrect.
- cPAH PRG values are different due to the change in the cancer slope factor for BaP per the *Toxicological Review of Benzo(a)pyrene* (EPA 2017) and as described in detail in the ESD.

Errors in FS Tables Identified in Errata #2

The following issues were identified in Errata #2. These issues and their resolutions are repeated in this memorandum so that the FS table errata pages and their explanations are consolidated.

- FS Table 2.2-8: The logistic regression model (LRM) derived sediment quality value (SQV) for 4,4'-DDE in BERA Table 6-11 is 50 µg/kg when the SQV is converted to µg/kg dry weight using the equation in FS Appendix B Section B4.1. This LRM-derived SQV was mistakenly not translated into FS Table 2.2-8, where it should have been selected as the PRG. The LRM-derived SQV for DDE in FS Table 2.2-8 was erroneously listed as 359 µg/kg.
- FS Table 2.2-11: The values for both the TRV and ARAR appear to have been rounded in FS Table 2.2-11 for total PCBs. The correct 0.014 µg/L value is shown in FS Table 2.1-4 Numeric Criteria Associated with Chemical-Specific ARARs. FS Table 2.2-11 should be revised to show 0.014 µg/L for PCBs for "TRV from BERA," "ARAR or

TBC,” and “PRG.” The value 36.5 µg/L should be added to the “ARAR or TBC” column for zinc as this is a United States and State of Oregon ARAR as shown on FS Table 2.1-4.

Conclusions

Discrepancies in the exposure parameters resulted in calculation errors for cancer risk and non-cancer hazard for RAO 1 in FS Table B3-4, but the errors in FS Table B3-4 did not change the final PRG selection. The calculation errors in FS Table B3-5 resulted in incorrect PRG values presented in FS Table 2.2-5 and incorrect ROD Table 17 fish tissue target levels. In addition, FS text errors were uncovered in this evaluation. Based on the evaluation presented in this memo, the following changes listed below and shown on the attached errata pages should be made:

- In ROD Table 17:
 - The fish tissue target level for PBDE should be changed to 1.28 µg/kg. (The fish tissue target level for pentachlorophenol is already correctly listed as 2.5 µg/kg on ROD Table 17 despite the error in FS Table 2.2-5.)
 - The basis for the fish tissue target level for mercury should be changed to “R_H” to indicate that it is a human health risk-based value.
 - cPAH CUL values should be updated as described in detail in the ESD.
- In FS Tables and FS Appendix B:
 - FS Table B3-1 should be updated to reflect the corrected exposure parameters and scenarios shown on **Tables 1 and 4**.
 - FS Table B3-2 should be updated to reflect the corrected toxicity values shown on **Table 2**.
 - FS Tables B3-4 and B3-5 should be updated to reflect the recalculated human health risk-based PRGs shown on **Tables 3 and 5**, respectively.
 - FS Table 2.2-4 should be updated to reflect the human health risk-based PRGs that were calculated in the ESD.
 - FS Table 2.2-5 should be updated to reflect:
 - the recalculated human health risk-based PRGs shown on **Table 5**
 - mercury tissue ARAR level of 0.3 mg/kg to match the correct value from *Water Quality Criterion for the Protection of Human Health: Methylmercury* (EPA 2001)
 - FS Table 2.2-8 should be revised to show the corrected risk-based PRG of 50 µg/kg for DDE.
 - FS Table 2.2-11 should be revised to show the corrected value of 0.014 µg/L for PCBs for “TRV from BERA,” “ARAR or TBC,” and “PRG.” The zinc ARAR of 36.5 µg/L should be added to the “ARAR or TBC” column.
 - Definition of PRG_{tissue} in Section B3.2.1 has the wrong units. Calculation of PRG using the equations (B3-15, B3-16, and B3-17) shown would result in PRG in units of mg/kg, not µg/kg.
 - Definition of ED_a in Section B3.2.2 has the wrong units. Exposure duration of the adult should be in years not days. (Note that the ED_{inf} is correctly shown in units of day.)
 - In Section B3.2.2, the text should indicate that the Infant Consumption of Breast Milk Calculation was only conducted for bioaccumulating chemicals with an infant RfD.
 - In Section B3.2.2, the text should describe the different methodology used for the Infant Consumption of Breast Milk Calculation used for PBDE.

References

CDM Smith. 2019. *Benzo(a)Pyrene Non-Cancer HQs and PRGs*. October 9.

EPA. 2017. *Toxicological Review of Benzo[a]pyrene*. Integrated Risk Information System, National Center for Environmental Assessment, Office of Research and Development. Washington, DC. January 19.

EPA. 2016a. *Portland Harbor RI/FS, Final Remedial Investigation Report*. February 8.

EPA. 2016b. *Portland Harbor RI/FS, Feasibility Study*. June 8.

EPA. 2001. *Water Quality Criterion for the Protection of Human Health: Methylmercury*. January.

ODEQ, 2010. *Human Health Risk Assessment Guidance*. October.

Tables

Table 1 - Summary of Exposure Parameters for PRG Calculations

Table 2 - Summary of Chemical-Specific Toxicity Values

Table 3 - Summary of Recalculated PRGs from FS Table B3-4 Risk-Based Human Health PRGs for RAO 1

Table 4 - Summary of Exposure Parameters for Tissue Exposures for PRG Calculations

Table 5 - Summary of Recalculated PRGs from FS Table B3-5 Risk-Based Human Health PRGs for RAO 2

Attachments

- Portland Harbor Feasibility Study, dated June 2016 (related Tables)
 - FS Tables 2.2-4, 2.2-5, 2.2-8, 2.2-11
 - Tables B3-1, B3-2, B3-4, and B3-5 in Appendix B
- Portland Harbor Human Health Risk Assessment, dated March 28, 2013 (related Tables)
 - Tables 3-21, 3-22, and 3-24
 - Table 7-1
- Errata Pages from Portland Harbor Feasibility Study

Attachments

Tables from Portland Harbor Feasibility Study, dated June 2016

Tables from Portland Harbor Human Health Risk Assessment,
dated March 28, 2013

Errata Pages from Portland Harbor Feasibility Study